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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
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09/313,764 05/18/99 KURAMATA

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EXAMINER

COLEMAN, W

ART UNIT

PAPER NUMBER

2823

DATE MAILED:

04/25/01

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary

Application No.

09/313,764

Applicant(s)

KURAMATA ET AL.

Examiner

W. David Coleman

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 15 February 2001.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-24 is/are pending in the application.
- 4a) Of the above claim(s) 5, 17 is/are withdrawn from consideration.
- 5) ☒ Claim(s) 8-13 and 18-20 is/are allowed.
- 6) ☒ Claim(s) 1-4, 6-7 and 21-24 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 18 May 1999 is/are objected to by the Examiner.
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

- 15) ☒ Notice of References Cited (PTO-892)
- 16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 17) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 4.
- 18) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 19) ☐ Notice of Informal Patent Application (PTO-152)
- 20) ☐ Other:

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of Group I invention, claims 1-4, 6-13 and 18-24 in Paper No. 8 is acknowledged.

Drawings

2. The drawings are objected to under 37 CFR 1.83(a) because they fail to show layer 17 as described in the specification. Any structural detail that is essential for a proper understanding of the disclosed invention should be shown in the drawing. MPEP § 608.02(d). Correction is required.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1, 2, 3, and 21-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Edmond et al., U.S. Patent 6,120,600 in view of Nakamura et al., U.S. Patent 5,747,832.
5. Pertaining to claims 1, 2, 21, 22 and 23, Edmond (600) discloses a semiconductor device substantially as claimed. See **FIG. 2**, where a silicon carbide (SiC) substrate **41** has a first conductivity (n-type) and a buffer layer formed on the substrate **14** with a composition represented by the compositional parameter x as $Al_xGa_{1-x}N$. A first cladding layer **43**

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comprises a first conductivity type (n-type) formed epitaxially, an active layer 45 formed epitaxially formed on the first cladding layer. A second cladding layer 50 having a second opposite conductivity type (p-type). The second cladding layer is of an epitaxial nature (see columns 7-8, where Edmond discloses epitaxial growth temperatures and process). A first electrode 54/55 is provided to inject first-type carriers having a first polarity into the second cladding layer 50 and a second electrode provided on the substrate so as to inject second type (p-type) carriers having a second polarity. The buffer layer having a compositional parameter x larger than 0 but smaller than 0.4 ($0 < x < 0.4$) as seen in FIG. 6. However, Edmond fails to disclose the carrier concentration in the range as claimed. Nakamura discloses an $\text{Al}_x\text{Ga}_{1-x}\text{N}$ layer comprising a carrier concentration of $1 \times 10^{20}/\text{cm}^3$ (column 14, line 3) also pertaining to claim 21, the p-type layer is doped with Mg (column 6, line 63). In view of Nakamura, it would have been obvious to one of ordinary skill in the art to teach the claimed carrier concentration because the claimed range provides a low-resistivity layer (column 13, line 23).

6. Pertaining to claims 3 and 21, Edmond (600) discloses a semiconductor device having a compositional parameter x of a buffer of less than 0.09 (where $x < 0.09$). See FIG. 6, where the compositional parameters are shown.
7. Claims 4 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Edmond et al., U.S. Patent 6,120,600 in view of Nakamura et al., U.S. Patent 5,747,832 as applied to claims 1-3 above, and further in view of Powell et al., U.S. Patent 6,165,874.

Edmond (600) in view of Nakamura discloses a semiconductor device substantially as claimed as discussed above. However, the combined teachings fail to teach the crystal

orientation of the silicon carbide substrate. Powell discloses a semiconductor device wherein the crystal orientation is taught as Applicant's claimed orientation. See column 7, lines 15-28, where silicon carbide polytypes are formed by the stacking of double layers of Si and C atoms. Each double layer maybe be situated in one of three positions, known as ABCACBABCACB... for 6H. The stacking direction is designated as the crystal c-axis and is in the crystal [0001] direction; it is perpendicular to the basal plane which is the crystal (0001) plane. In view of Powell, it would have been obvious to one of ordinary skill in the art to claim a silicon carbide substrate having a crystal orientation of (0001) in the combined teachings of Edmond (600) and Nakamura because the GaN based Group III and Group V nitrides semiconductors have bonded polytypes similar to those of SiC (column 7, lines 46-50).

8. Claims 6 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Edmond et al., U.S. Patent 6,120,600.

Pertaining to claims 6 and 7, Edmond (600) discloses a semiconductor device substantially as claimed. See **FIG. 2**, where a silicon carbide (SiC) substrate **41** has a first conductivity (n-type) and a buffer layer formed on the substrate **14** with a composition represented by the compositional parameter x as $\text{Al}_x\text{Ga}_{1-x}\text{N}$. A first cladding layer **45** comprises a first conductivity type (n-type) formed epitaxially on optical wave-guide layer **46**, comprised of GaN. A second cladding layer **47** having a second opposite conductivity type (p-type). The second cladding layer is of an epitaxial nature (see columns 7-8, where Edmond discloses epitaxial growth temperatures and process). A first electrode **54/55** is provided to inject first-type carriers having a first polarity into the second cladding layer **47** and a second electrode

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provided on the substrate so as to inject second type (p-type) carriers having a second polarity. The buffer layer having a compositional parameter x larger than 0 but smaller than 0.4 ($0 < x < 0.4$) as seen in FIG. 6, where x is less than the range claimed. However, Edmond (600) fails to teach the substrate having a top surface separated from a bottom surface of the active layer by a distance of about 1.6 μm or more.

Given the teaching of the references, it would have been obvious to determine the optimum thickness, temperature as well as condition of delivery of the layers involved. See *In re Aller, Lacey and Hall* (10 USPQ 233-237) "It is not inventive to discover optimum or workable ranges by routine experimentation. Note that the specification contains no disclosure of either the critical nature of the claimed ranges or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen dimensions or upon another variable recited in a claim, the Applicant must show that the chosen dimensions are critical. *In re Woodruff*, 919 f.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Pertaining to claim 7, see FIG. 6, where the compositional parameters are disclosed teaching the claimed range, where x having a value equal to or larger than 0.8 but smaller than 0.5, the compositional parameter parameter y having a value equal to or larger than 0.05 but equal to or smaller than the compositional parameter z having a value smaller than the compositional parameter y .

Allowable Subject Matter

9. Claims 8-13 and 18-20 allowed.
10. The following is an examiner's statement of reasons for allowance: prior art does not teach a semiconductor device wherein a substrate of SiC having a first conductivity type; a

first cladding layer having a first conductivity type, the first cladding layer being formed on the substrate epitaxially; an active layer formed epitaxially on the first cladding layer; a second cladding layer having a second, opposite conductivity type, the second cladding layer being formed on the active layer epitaxially; a third cladding layer having a second conductivity type, the third cladding layer being formed on the second cladding layer epitaxially; a contact layer of a second conductivity type, the contact layer being formed on the third cladding layer; a first electrode provided on the contact layer; a second electrode provided on the substrate; the third cladding layer forming a ridge structure having a T-shaped cross-section, the third cladding layer including, at a bottom part thereof, a pair of cuts, such that the cuts penetrate from respective lateral sides of the ridge structure toward a center of the ridge structure..

11. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

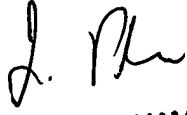
12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to W. David Coleman whose telephone number is 703-305-0004. The examiner can normally be reached on 9:00 AM-5:00 PM.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael M. Fahmy can be reached on 703-308-4918. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7721 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

WDC
April 23, 2001


LONG PHAM
PRIMARY EXAMINER